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February 6, 2012

Andrew Frierdich, P.E. Illinois Environmental Protection Agency Remedial Project Management Section Bureau of Land Springfield, IL 62794 3 paper copies, one electronic copy

Re:

Vapor Intrusion Sampling Work Plan, February 2012

GE facility, 709 West Wall St., Morrison, IL

Consent Order No. 04 CH 28

Dear Mr. Frierdich:

Attached please find a Vapor Intrusion Sampling Work Plan, prepared on behalf of The General Electric Company (GE), by Arcadis U.S. Inc., for the referenced site. This work plan is based on data from soil, aroundwater and soil gas samples which were collected as described in the GE Morrison Facility Work Plan, prepared by MWH Americas, Inc., dated October 2011. Please note that a copy of this work plan has been sent to Jonathan Adenuga of the United States Environmental Protection Agency, Region V.

Please feel free to contact me with any questions.

Lewis S. Streeter Project Manager

LSS/dd

Attachment: Vapor Intrusion Sampling Work Plan, February, 2012

February 6, 2012 Page 2

CC:

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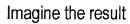
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# **General Electric Company**

# Vapor Intrusion Sampling Work Plan

Morrison, Illinois

February 2012



Madine Weinbug

Nadine Weinberg Principal Scientist

# Vapor Intrusion Sampling Work Plan

**GE Morrison Facility** 

Prepared for: General Electric Company

Prepared by: ARCADIS U.S., Inc. 482 Congress Street Suite 501 Portland Maine 04101 Tel 207 828 0046 Fax 207 828 0062

Our Ref.: ME000143,0001

Date: February 2012

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#### 1. Introduction

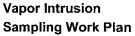
This Vapor Intrusion Work Plan (VI Work Plan) presents the activities to be conducted to evaluate the potential for vapor intrusion (VI), at residential homes located south of the GE Morrison Facility (Site) located in Morrison, Illinois. The VI Work Plan supplements the previous work outlined in the October 2011 GE Morrison Facility Work Plan prepared by MWH Americas, Inc. (MWH 2011 work plan) on behalf of the General Electric Company (GE). The MWH 2011 work plan was submitted to both the Illinois Environmental Protection Agency (Illinois EPA), and U.S. Environmental Protection Agency (USEPA), and approved by Illinois EPA in November 2011. Evaluation of the VI pathway was requested as part of the MWH 2011 work plan due to the presence of volatile organic compounds (VOCs) in groundwater. Based on this request, the MWH 2011 work plan included on-site soil gas and groundwater sampling to start investigating the VI pathway.

The objective of this VI Work Plan is to obtain additional data to evaluate whether the VI pathway may be complete at homes located directly downgradient from the Site and over shallow groundwater containing VOCs. The VI Work Plan includes a summary of previous on-site investigations including the recent on-site evaluation of soil gas, a VI conceptual site model (CSM), sampling methods for collecting sub-slab soil gas and indoor air samples in residential homes, and a reporting schedule.

# 2. Site Background

The former GE Morrison Facility operated in Morrison, Illinois, from the late 1940s until 2010 when the facility was closed. During its operation, the facility manufactured components for motors and motor control equipment that were eventually assembled at other locations. Prior to 1994, GE used chlorinated organic solvents for removing oil from the components prior to subassembly into units for installation in the final product. The degreasing operations occurred in the Main Building (Building No. 1) at two separate locations: a small immersion tank degreaser and at a larger continuous process line degreaser.

A summary of historical investigation activities at the Site was provided in the MWH 2011 work plan. As outlined in the 2011 work plan, investigation activities started in 1986 with the discovery of chlorinated volatile organic compounds (CVOCs) in three of four City of Morrison water supply wells located near Rock Creek on the south side of Morrison. During the summer of 1988, City wells 1 and 2 were closed in accordance







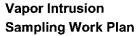
with Illinois law and an air stripper was constructed to treat the groundwater from City Well 3. Soil and groundwater investigations have continued since that time.

# 3. On-Site Investigation

Consistent with the MWH 2011 work plan, field activities were initiated on December 5, 2011and are summarized below:

- Initiation of a private well survey to determine if residents of the homes west of Heaton Street and south of Morris Avenue are utilizing private potable wells.
- Installation of two new downgradient monitoring wells.
- Collection of groundwater samples from the two new and 11 existing monitoring wells and analysis for VOCs by USEPA Method 8260B.
- Collection of soil samples beneath and adjacent to the two former degreaser areas and analysis for VOCs by USEPA Method 8260B.
- Collection of soil samples from beneath the former 1,1,1- trichloroethane
   (1,1,1-TCA) aboveground storage tank; along sanitary and storm sewers that
   are located adjacent to and beneath the building; and near two former soil gas
   sample locations (SG-21 and SG-32) beneath the building and analysis for
   VOCs by USEPA Method 8260B.
- Collection of grab water table groundwater samples at seven soil boring locations and analysis for VOCs by USEPA Method 8260B.
- Collection of four soil samples for physical characterization and geotechnical testing.
- Collection of soil vapor samples from 13 locations along the property boundary as the first step in a soil vapor intrusion investigation.

Figure 1 presents all the sample locations and samples collected at the Site during December 2011 and January 2012. The results of the shallow groundwater samples and soil vapor samples are discussed below in greater detail.





#### 3.1 Shallow Groundwater Results

A total of seven shallow groundwater samples were collected from around the former GE Morrison facility. The results of the shallow groundwater sampling are presented in Table 1 and shown in Figure 2. The shallow groundwater samples represent VOC concentrations at the top of the water table. At three of the sample locations (SB-26, SB-22, and SB-23), no VOCs were detected in shallow groundwater. Of the four samples with detections, 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), and trichloroethene (TCE) were detected in all four locations. Downgradient of the facility, only TCE was detected at concentrations above maximum contaminant levels (MCLs).

# 3.2 Soil Vapor Sampling Results

Soil vapor samples were collected from the north, east, and southern sides of the former GE Morrison facility. Consistent with the MWH 2011 work plan, soil vapor samples were collected from two depths, 5 feet below ground surface (bgs) and 2 feet above the water table using a post-run tubing (PRT) system, where sufficient depth to water was present. At five locations, SG-9 though SG-13, the depth to water was less than 10 feet bgs and it was only possible to collect one sample at 5 feet bgs. At least 4 to 5 feet of distance between sample points is necessary to ensure proper installation of the sampling system. At closer distances, it is possible to have cross-contamination between points.

The results of the soil vapor sampling are presented in Table 2 and Figure 3. Ten constituents were detected in soil vapor, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, chloroform, cis-1,2-dichloroethene, methylene chloride, trans-1,2-dichloroethene, TCE, tetrachloroethene (PCE) and vinyl chloride. At locations SG-10 and SG-13, no VOCs were detected. Only TCE was detected at locations SG-11 and SG-12 at low levels.

The highest VOC concentrations were seen at locations SG-1, SG-5, and SG-6, while locations SG-7, SG-8, and SG-9 had much lower concentrations. SG-1 was located near the former above and below ground storage tanks on the north side of the facility. SG-5 and SG-6 were the western most locations on the south side of the facility. At SG-1, higher concentrations were detected at 5 feet bgs compared to the deeper sample collected from 12 feet bgs. Similar results were seen at SG-2 and SG-3, also collected from the north of the facility. As discussed below, these results are indicative of contribution from a soil source. At all other soil vapor locations where two depths



were collected, higher VOC concentrations were seen in the sample collected closer to the water table.

### 3.3 Data Evaluation and Recommendations

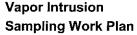
To evaluate the soil vapor results, the USEPA Regional Screening Levels (RSLs) for residential air were converted to soil vapor RSLs using conservative attenuation factors of 0.1 and 0.01 for shallow and deep soil gas consistent with USEPA (2002) guidance. The comparison of the soil vapor RSLs to the shallow and deep soil vapor data is presented in Table 2. As shown in Table 2, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, chloroform, PCE, TCE, and vinyl chloride were detected above the soil vapor RSLs in at least one sample.

At sample locations SG-10, SG-11, SG-12, and SG-13 on the eastern and southeastern side of the facility, VOCs were either not detected or were detected at low levels below the soil vapor RSLs. These results are consistent with the shallow groundwater findings (Figure 2) along the eastern and southeastern sides of the buildings. As noted above, no VOCs were detected in shallow groundwater samples collected from locations near SG-10, SG-11, SG-12, and SG-13. These results indicate that the vapor intrusion pathway along the eastern and southeastern boundary of the Site is incomplete and no further investigations are necessary.

At all other soil vapor locations, at least one constituent was detected at a concentration greater than the soil vapor RSLs. In particular, 1,1-DCA, 1,1-DCE, and TCE were detected in several shallow soil vapor samples south of the facility at levels that were above the soil vapor RSLs. It should be noted, however, that the comparison of the soil vapor RSLs to the soil vapor data is based on a very conservative assumption about attenuation through the vadose zone and into an individual's home. USEPA's (2008) attenuation factor database indicates that an attenuation factor of 0.0063 is an appropriate 50<sup>th</sup> percentile value based on empirical data collected from sites. Using this attenuation factor results in a much more limited number of samples above the soil vapor RSLs in soil vapor points south of the facility.

# 4. Vapor Intrusion Conceptual Site Model

A vapor intrusion conceptual site model (VI CSM) was developed to support the interpretation of the soil vapor results from the former GE Morrison facility. As recommended by ITRC (2007) guidance, the goal of the VI CSM is to develop a three-dimensional concept of the Site that provides information on historical sources, soils,





geology, hydrology, groundwater quality data and flow direction, subsurface transport mechanism, and potential receptors. This information aids in creating a narrative description and a working hypothesis of the vapor migration exposure pathway that can be used to more fully understand the potential for vapor intrusion at the Site.

#### 4.1 Sources

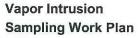
Constituents of concern potentially attributable to operations at the former GE Morrison facility include TCE, 1,1,1-TCA, 1,1-DCE, 1,1-DCA, PCE, and cis-1,2-dichloroethene. These constituents have been detected in groundwater downgradient of the GE facility. The potential sources of VOCs to groundwater have been investigated starting in 1987 when TCE was detected in the City of Morrison municipal supply wells. On-site sources potentially include the former TCE underground storage tank and the 1,1,1-TCA aboveground storage tank located on the northern side of the facility, and two former degreaser areas inside the building.

### 4.2 Geology

Previous and on-going groundwater investigations have provided information on geology and hydrogeology, as well as the nature and distribution of VOC-impacted groundwater at the Site. The City of Morrison, including the Site, is located in the Rock River Hill Country, which is characterized by subdued rolling hills that reflect undulations in the underlying bedrock surface.

The region is underlain by unconsolidated materials of predominantly glacial origin. Near the Site, the upland area is underlain by a deposit of fine to coarse sand and silty sand that has been interpreted as possible glacial outwash (Canonie 1989). These deposits were observed to range in thickness from 9 to 27 feet. Although the thickness of the unconsolidated materials varies around the Site, information from two borings drilled near the former Facility (MW-4UL and MW-1LD) indicates that depths range from approximately 10 feet to 30 feet.

To the west of the plant, in the adjacent Rock Creek valley, the bedrock surface drops off considerably (~ 50 feet). This bedrock valley is partially filled with deposits of sand and gravel interbedded with silty sand, silt, and clay layers. These deposits are likely glaciofluvial (i.e., glacial lake) and/or alluvial in origin and are on the order of 70 to 100 feet thick.





# 4.3 Hydrogeology

Previous investigators have defined two hydrostratigraphic units of interest in the Site vicinity: the unconfined aquifer unit (upper groundwater aquifer) and the Maquoketa shale confining unit (Geotrans 2001). The unconfined aquifer consists of the surficial unconsolidated sediments as well as the underlying solution-weathered portion of the Silurian dolomites. Data from wells MW-4UD and G-105S (Geotrans 2001) indicates that the depth to the unconfined aquifer near the former Facility ranges from about 5 to 15 feet below grade. The depth to groundwater fluctuates about five feet seasonally, with the water table being nearest to the land surface during the spring. Variations in depth to groundwater is supported by the recent on-site investigations that indicated that the depth to water was approximately 20 feet near the northwest corner of the Site. Depth of the water decreased south and southeast of the Site to approximately 10 feet bgs.

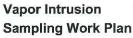
Rock Creek is the local discharge zone for shallow groundwater in the area of groundwater impacts (Geotrans 2001). Installation of additional monitoring wells and collection of groundwater samples, conducted as described in the MWH 2011work plan will help confirm the direction of groundwater flow in the vicinity of the former GE facility.

#### 4.4 Vapor Intrusion Pathways

A comparison of the soil vapor sample results to screening levels for shallow soil vapor indicates that several constituents were detected above screening levels. Given the soil type within the vadose zone (fine to coarse sand and silty sand), it is possible that VOCs may migrate from the groundwater table and volatilize upward through the soil matrix into overlying structures.

# 5. Residential Sampling Approach

Sub-slab soil vapor and indoor air samples will be collected from approximately seven homes and one commercial building located south and southwest of the former GE Morrison Facility. Based on recent sampling, this area is believed to be downgradient of the area with the highest shallow groundwater and soil vapor results on-site. The homes to be sampled are located along West Morris Street between Oak Street and Willow Street as identified on Figure 4. GE is currently in the process of contacting each of the homeowners to obtain access for sampling.







GE recommends that the Illinois EPA notify the property owners in writing of the sampling request and provide the owners with an access agreement for their review. This approach will aid in securing home owner participation. GE will then call each property owner, as referenced in the letter, to set up an initial meeting and subsequent sampling appointments. The locations to be sampled and the sample methodologies are presented below.

#### 5.1 Site Reconnaissance

A site reconnaissance will be conducted at every building to be sampled after receipt of a signed access agreement. ARCADIS will attempt to conduct the site reconnaissance at least 24 hours prior to sampling; however, depending on owner access issues, the site reconnaissance may be conducted concurrent with sampling. The overall goal of the site reconnaissance is to complete a building survey that identifies the building and foundation condition; building materials; heating, ventilation, and air conditioning (HVAC) operation; and any preferential vapor migration pathways (i.e. sump pump). In addition, a product inventory will be completed to identify and list all products that are stored or used within the structure. Any products that contain VOCs will be requested to be removed from the occupied structure at least 24 hours prior to sampling, if feasible. A copy of the building survey and product inventory form is provided in Appendix A.

During the site reconnaissance, ARCADIS will provide the building owner or tenants with a copy of Instructions for Occupants during Indoor Air Sampling Events (Appendix B). As necessary, ARCADIS will also schedule and confirm all remaining sampling activities with the property owner/resident.

## 5.2 Sample Locations

All sample locations will be finalized with the home or building owner during the site reconnaissance and prior to sampling. Based on information available from the county tax assessor's office, three foundation construction types are expected to be encountered in the buildings to be sampled: slab on grade, basement construction, or partial basement. The foundation construction and size of the structure will determine the type and location of the sub-slab soil vapor and indoor air samples to be collected.

In general, one sub-slab sample will be collected in buildings less than 1,500 square feet (sq ft), and two samples in buildings over 1,500 sq ft. Building construction will influence sampling as follows:

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- Basement (full or partial) construction: One or two sub-slab soil vapor sample(s) and one basement indoor air sample.
- Slab-on-grade construction: One or two sub-slab soil vapor sample(s) and one indoor air sample from the first floor.
- Partial basement construction: One sub-slab soil vapor sample from the basement, one sub-slab vapor sample from the first floor, and one first floor indoor air sample. An additional basement indoor air sample may be collected depending on accessibility (i.e., occupancy potential).

Specific samples to be collected in each home or commercial building are presented in Table 3.

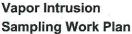
Sub-slab soil-gas and indoor air samples will be collected as close as possible to the center of each building/home. Actual sampling locations are expected to be adjusted with information from the structure reconnaissance and input from the property owner or tenant. This includes adjusting for utilities that may be present beneath the structure, in a crawl space, or underneath the slab.

# 5.3 Sample Methodology

# 5.3.1 Sub-slab Soil Vapor

All sub-slab soil vapor samples will be collected from permanent sampling points installed as detailed in SOP-1 (Appendix C). A helium leak test will be completed prior to sampling to verify the seal of the sample point (SOP-2, Appendix C). If the seal is compromised, the sample point will be re-sealed until the helium leak test passes. The sample canister train will also be evaluated using a leak down test (SOP-3, Appendix C).

Sub-slab soil-gas samples will be collected using 6-liter SUMMA® canisters with attached pre-set flow regulators. A total of three volumes of air (open space of tubing and sample point) will be purged into a Tedlar® bag prior to sampling with a flow rate not exceeding 200 milliliters per minute. Flow regulators will be pre-set by the laboratory to provide uniform sample collection over a 30-minute sampling period. The valve on the SUMMA® canister will be closed when approximately 5 inches of mercury remains in the canister, leaving a vacuum in the canister as a means for the laboratory to verify the canister does not leak while in transit. Samples will be submitted under



chain-of-custody protocols to the analytical laboratory. All samples will be analyzed for site-related VOCs in accordance with USEPA Method TO-15 using standard detection limits. The list of constituents to be evaluated and detection limits are provided in Table 4

#### 5.3.2 Indoor and Ambient Air

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Indoor and ambient air samples will be collected in accordance with SOP-4 (Appendix C). Indoor air and ambient air samples will be collected at breathing height (4 to 5 feet). The specific location for indoor air samples will be dependent on the structure and site reconnaissance. If the structure has a partial basement, indoor air samples will be collected from first floor of the structure. A sample will only be collected from the partial basement if the space is accessible for occupancy.

Ambient air samples will be collected from an upwind location. Should multiple indoor air samples be collected, one ambient sample will be considered representative of the day of sampling. The wind direction will be determined each day and the sample canister will be placed accordingly. Ambient air samples will be collected over the same 24-hour sampling period as indoor air samples.

Indoor air samples will be collected using 6-liter SUMMA<sup>®</sup> canisters with attached preset flow regulators. Flow regulators for indoor air sampling will be pre-set by the laboratory to provide uniform sample collection over a 24-hour sampling period.

The valve on the SUMMA<sup>®</sup> canister will be closed when approximately 5 inches of mercury vacuum remains in the canister or when the sample duration is complete (e.g., 24 hours), leaving a vacuum in the canister as a means for the laboratory to verify the canister does not leak while in transit. Samples will be submitted under chain-of-custody protocols to the analytical laboratory. All samples will be analyzed for a site-specific list of VOCs in accordance with USEPA Method TO-15 using standard detection limits (Table 4).

# 6. Communication with Residents and Business Owners

GE anticipates starting the sampling request process by working with Illinois EPA to send an informational letter to targeted home and business owners to request their participation in the sampling effort. The letter would include a copy of the access agreement and a point of contact for scheduling the sampling appointments. GE's Community Contact, Alison Spare, will call owners after they have received Illinois

# Vapor Intrusion Sampling Work Plan



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EPA's letter to arrange an initial meeting. The meeting will include Ms. Spare and a GE representative. The purpose of the meeting is to secure the access agreement, review sampling procedures, confirm future sampling appointments, and when possible conduct sampling reconnaissance activities.

GE will also communicate with Illinois EPA Community Relations Coordinator Michelle Tebrugge, Department of Environmental Health contact Steve Johnson, Whiteside County Health Department contact Gene Johnston ,and City of Morrison officials about the sampling effort.

# 7. Reporting and Schedule

GE anticipates starting the implementation of the tasks to obtain access from building owners during the week of February 20, 2012. If delays are encountered because access cannot be secured, USEPA and Illinois EPA will be notified.

At each residence within the neighborhood, sampling is expected to be conducted over a three-day period; these three days may not be consecutive based on building access. GE anticipates the following schedule at each home; however, depending on homeowner requests, the schedule my change.

- Visit 1: Install permanent sub-slab soil vapor sample ports and complete building survey. Containerize any volatile materials and remove from living space.
- Visit 2: Start indoor air sample.
- Visit 3 (24 hours later): Finish indoor air sample and collect sub-slab soil vapor sample.

Field staff will document all activities (e.g., pre-sampling reconnaissance and sampling logs) as they are implemented. In addition, field staff will complete sample specific sample logs that denote the sample canister numbers, sample start and finish time, canister vacuums, weather conditions, and any other specific steps taken during the sampling event.

Following receipt of the laboratory analytical results, a decision analysis will be conducted to evaluate the potential for vapor intrusion and the need for additional activities. These additional activities may include additional evaluation of these

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properties, sampling of additional properties, or mitigation, if appropriate. Each building will be evaluated on a case-by-case basis considering the indoor air and sub-slab soil vapor results and indoor air and soil vapor RSLs.

A summary report will be submitted to USEPA that will include:

- · A summary of all field activities
- A summary of all sub-slab soil vapor, ambient air, and indoor air sampling results
- A comparison of constituents detected in sub-slab soil vapor and indoor air to RSLs
- A copy of all building survey forms, product inventories, sample collection logs, access agreements, and other field notes

#### 8. References

- Canonie Environmental Services Corp. (Canonie). 1989. Phase II Remedial Investigation. Morrison, Illinois.
- Geotrans. 2001. Natural Attenuation Analysis and Groundwater Modeling. Morrison, Illinois. October.
- ITRC. 2007. Vapor Intrusion Pathway: A Practical Guide. Interstate Technology and Regulatory Council. January.
- MWH. 2011. GE Morrison Facility Work Plan. Consent Order No. 04 CH28.October.
- USEPA. 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). EPA530-D-02-004. November.
- USEPA. 2008. USEPA's Vapor Intrusion Database: Preliminary Evaluation of Attenuation Factors. U.S. Environmental Protection Agency. Office of Solid Waste. March.



Table 1. Shallow Groundwater Sample Results, GE Morrison, Morrison, Illinois

Compound	Units	IEPA Class I Groundwater Standard	SB15-12	SB17-24	SB21-20	SB21-20 Duplicate	SB22-9	SB23-11	SB24-15	SB26-14
VOC (SW846 8260)					<del></del>	<u>'</u>				
1,1,1-Trichloroethane	μg/l	200	31	2.8 J	190	170	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2,2-Tetrachloroethane	µg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloroethane	µg/l	5	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/l		71	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,1-Dichloroethane	µg/l	700	360	2.3 J	75	68	5.0 U	5.0 U	50	5.0 U
1,1-Dichloroethene	µg/l	7	66	2.4 J	110	110	5.0 U	5.0 U	1.3 J	5.0 U
1,2,4-Trichlorobenzene	µg/l	. 70	10 U	5.0 U	0.50 J	2.0 J	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromo-3-chloropropane	µg/l	0.2	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dibromoethane (EDB)	µg/l	0.05	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichlorobenzene	µg/l	600	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	μg/l	5	2.2 J	5.0 U	1.6 J	1.7 J	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloropropane	µg/l	5	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,3-Dichlorobenzene	μg/l	***	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dichlorobenzene	μg/l	75	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Butanone (MEK)	µg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
2-Hexanone	μg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
4-Methyl-2-Pentanone (MIBK)	µg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	µg/l	6,300	40 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	µg/l	5	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromodichloromethane	μg/l	0.2	10 Ü	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromoform	μg/l	1	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Bromomethane	μg/l	_	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon disulfide	µg/l	700	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Carbon tetrachloride	μg/l	5	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chlorobenzene	μg/l	100	10 U	5.0 Ų	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroethane	μg/l	_	68	5.0 U	3.6 J	3.5 J	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	μg/l	0.2	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloromethane	μg/l	_	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
cis-1,2-Dichloroethene	μg/l	70	10 U	150	26	24	5.0 U	5.0 U	19	5.0 U
cis-1,3-Dichloropropene	µg/l	1	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5,0 U	5.0 U
Cyclohexane	µg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Dibromochloromethane	µg/l	_	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 Ų	5.0 U
Dichlorodifluoromethane	μg/l	-	13	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Ethylbenzene	μg/l	700	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Isopropylbenzene (Cumene)	μg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methyl Acetate	µg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylcyclohexane	µg/l		10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene Chloride	μg/l	5	3.9 J	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methyl-tert-butyl ether	μg/i	70	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Styrene	µg/l	100	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrachloroethene	µg/l	5	10 U	5.0 U	5.0	4.9 J	5.0 U	5.0 U	5.0 U	5.0 U
Toluene	µg/l	1,000	10 U	1.9 J	5.0 U	5.0 U	5.0 U	5.0 U	2.2 J	5.0 U
trans-1,2-Dichloroethene	µg/l	100	10 U	4.1 J	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
trans-1,3-Dichloropropene	µg/l	1	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Trichloroethene	µg/l	5	1.8 J	130	36		5.0 U	5.0 U	9.4	5.0 U
Trichlorofluoromethane	µg/l	_	10 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Vinyl chloride	µg/l	2	10 U	20	7.3	6.5	5.0 U	5.0 U	5.0 U	5.0 U
Xylenes, Total	μg/l	10,000	30 U	15 U	15 U	15 U	15 U	15 U	15 U	15 U

### Notes:

-- - Indicates there is no established screening criteria for this compound

# Bold - Indicates a detection of the noted compound

Highlighted compound indicates an exceedence of screening criteria

Italicized - Indicates that the reporting limit exceeded screening criteria

J - Estimated concentration above the adjusted method detection limit and

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit

μg/l - Micrograms per liter

U - Combound not detected

VOC - Volatile organic compounds

IEPA Class I Groundwater Standard - Illinois EPA Section 742, Appendix B, Table E - Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route

# **GARCADIS**

Table 2. Soil Vapor Sample Results, GE Morrison, Morrison, Illinois

	Residential	Sample					SG4-5									SG12-5	
00000	Shallow	No:	SG1-5	SG2-5	SG3-5	SG4-5	Duplicate	SG5-5	SG6-5	867-5	SG8-5	SG9-5	SG10-5	SG11-5	SG12-5	Duplicate	5G13-5
pundulos	Soil Vapor	Depth:	Depth: 5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs	5 ft bgs
	(hg/m³)	Units:	µg/m³	ug/m³	<sub>E</sub> m/brl	µg/m³	µg/m³	<sub>E</sub> w/6rl	m/Brl	<sub>E</sub> m/Brl	ng/m³	ng/m³	<sub>s</sub> m/grl	m/6rl	<sub>s</sub> m/grl	<sub>e</sub> w/brl	m/bri
VOC (TO15)																	
1,1,1-Trichloroethane	52,000		410,000	63	550	1.1	1.6	25,000	14,000	310	3.1	1.2	1.10	1.5	1.1 U	1.1 U	1.10
1,1,2,2-Tetrachloroethane	0.42		4000 U	1.4 U	19 U	1.4 U	1.4 U	510 U	470 U	11 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
1,1,2-Trichloroethane	1.5		3200 U	1.1 U	15 U	1.1 U	1.1 U	410 U	370 U	8.7 U	1.1 U	1.1 U	1.1 U	1.10	1.1 U	1.1 U	1.1 U
1,1-Dichloroethane	15		2300 U	2.8	42	0.81 U	0.81 U	300 U	280 U	6.5 U	0.81 U	38	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U
1,1-Dichloroethene	2,100		8,900	1.1	11.0	0.79 U	0.79 U	32,000	27,000	069	0.79 U	14	0.79 U	0.79 ∪	0.79 U	U 62.0	0.79 U
1,2-Dichloroethane	6.0		2300 U	0.81 U	110	0.81 U	0.81 U	300 U	280 U	6.5 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U
Carbon tetrachloride	4.1	į	3600 U	1.3 U	18 U	1.3 U	1.3 U	470 U	430 U	10 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
Chloroform	1.1		2800 U	177	23	0.98 U	0.98 U	360 U	330 U	7.8 U	0.98 U	12.2	0.98 U	U 86.0	0.98 U	0.98 U	0.98 U
cis-1,2-Dichloroethene	!		2300 U	0.79 U	120	0.79 U	0.79 U	300 U	270 U	7.8	0.79 U	32	0.79 U	0.79 U	0.79 U	0.62.0	0.79 U
Methylene Chloride	52		5000 U	1.7 U	24 U	1.7 U	1.7 U	650 U	590 U	14 U	1.7 U	3.5	1.7 U	1.7 U	1.7 U	U 2'1	1.7 U
Tetrachloroethene	4.1		7,100	1.4 U	19 U	1.4 U	1.4 U	510 U	460 U	11 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
trans-1,2-Dichloroethene	630		2300 U	0.79 U	30	0.79 U	0.79 U	300 U	270 U	6.3 ∪	0.79 U	2.5	0.79 U	0.79 U	0.79 ∪	U 62'0	0.79 U
Trichloroethene	4.3		6,400	70	2,000	1.10	1.1 U	940	470	120	1.1 U	7.	1.1 U	1.1	1.2	1.2	1.1 U
Vinyl chloride	1.6		1500 U	0.51 U	7.2 U	0.51 U	0.51 U	190 U	170 U	4.10	0.51 U	46	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U

	Residential	Sample	66.449		1,000	27.73	3,		97,500		SG8-10	Trip
Compound	Deep Soil	NO.		202-13	563-13	564-13	01-c5c	SGB-10	01-75¢	SG8-10	Duplicate	Blank
	vapor (va(m²)	Depth:	Depth: 12 ft bgs	13 ft bgs	13 ft bgs	13 ft bgs	10 ft bgs	10 ft bgs	10 ft bgs	10 ft bgs	10 ft bgs	
	(pg/ms)	Units:	µg/m³	µg/m³	m/6rl	<sub>£</sub> ш/бп	<sub>E</sub> ш/6rl	hg/m³	hg/m³	<sub>s</sub> w/brl	m/bri	mg/m3
VOC (TO15)												
1,1,1-Trichloroethane	520,000		71,000	6.7	5.3	44	52,000	19,000	4,400	130	160	1.1 U
1,1,2,2-Tetrachloroethane	4		089 U	1.4 U	2.4 U	6.1 U	1,100 U	500 U	240 U	5.0 U	2.7 U	1.4 U
1,1,2-Trichtoroethane	15		540 U	1.1 U	1.9 U	4.8 U	098 U	400 U	190 U	4.0 U	2.2 U	1.10
1,1-Dichloroethane	150		1,100	0.81 U	9.6	⊞ 810 ⊞	040 U	290 U	880	170	200	0.81 U
1,1-Dichloroethene	21,000		5,500	U 62.0	1.7	200	54,000	43,000	26,000	240	260	0.79 U
1,2-Dichloroethane	6		400 U	0.81 U	1.4 U	3.6 U	640 U	290 U	140 U	2.9 U	1.6 U	0.81 U
Carbon tetrachloride	41		630 U	1.3 U	2.2 U	5.6 U	0 066	460 U	220 U	4.6 U	2.5 U	1.3 U
Chloroform	11		490 U	0.98 U	1.7 U	4.3 U	U 077	350 U	170 U	6.2	6.1	0.98 U
cis-1,2-Dichloroethene	ł		390 U	0.79 U	22	3.5 U	620 U	290 U	140 U	150	160	0.79 U
Methylene Chloride	520		860 U	1.7 U	3.0 U	7.7 U	1,400 U	630 U	310 U	6.3 U	3.5 U	1.7 U
Tetrachloroethene	41		680 U	1.4 U	2.6	6.0 U	1,100 U	490 U	240 U	4.9 U	2.7 U	1.4 U
trans-1,2-Dichloroethene	6,300		390 U	0.79 U	1.4 U	3.5 U	620 U	290 U	140 U	19	20	0.79 U
Trichlaroethene	43		2,500	1.1 U	11	4.8 U	3,000	740	190	100	80	1.1 U
Vinyl chloride	16		250 U	0.51 U	U 68:0	2.3 U	400 U	190 U	90 U	1.9 U	1.0 U	0.51 U

Bold - Indicates a detection of the

noted compound

Highlighted compound indicates an exceedence of one or more screening criteria

Italicized - Indicates that the reporting limit exceeds.one or more screening criteria ug/m³ - Micrograms per cubic meter ft bgs - feet below ground surface

U - Compound is not detected

VOC - Volatile organic compounds



Table 4. Constituents and Analytical Reporting Limits, GE Morrison, Morrison IL

Analyte	TO-15 Method Rep	orting Limits (ug/m³)
,y.u	Soil Gas	Indoor Air
Carbon Tetrachloride	1.26	0.25
Chloroform	0.98	0.20
1,1-Dichloroethane	0.81	0.16
1,2-Dichloroethane	0.81	0.32
1,1-Dichloroethene	0.79	0.16
cis-1,2-Dichloroethene	0.79	0.16
trans-1,2-Dichloroethene	0.79	0.16
Methylene Chloride	1.74	2.78
1,1,1-Trichloroethane	1.09	0.22
1,1,2-Trichloroethane	1.09	0.22
1,1,2,2-Tetrachloroethane	1.37	0.27
Tetrachioroethene	1.36	0.27
Trichloroethene	1.07	0.21
Vinyl Chloride	0.51	0.20

Notes:

ug/m³ - micrograms per cubic meter

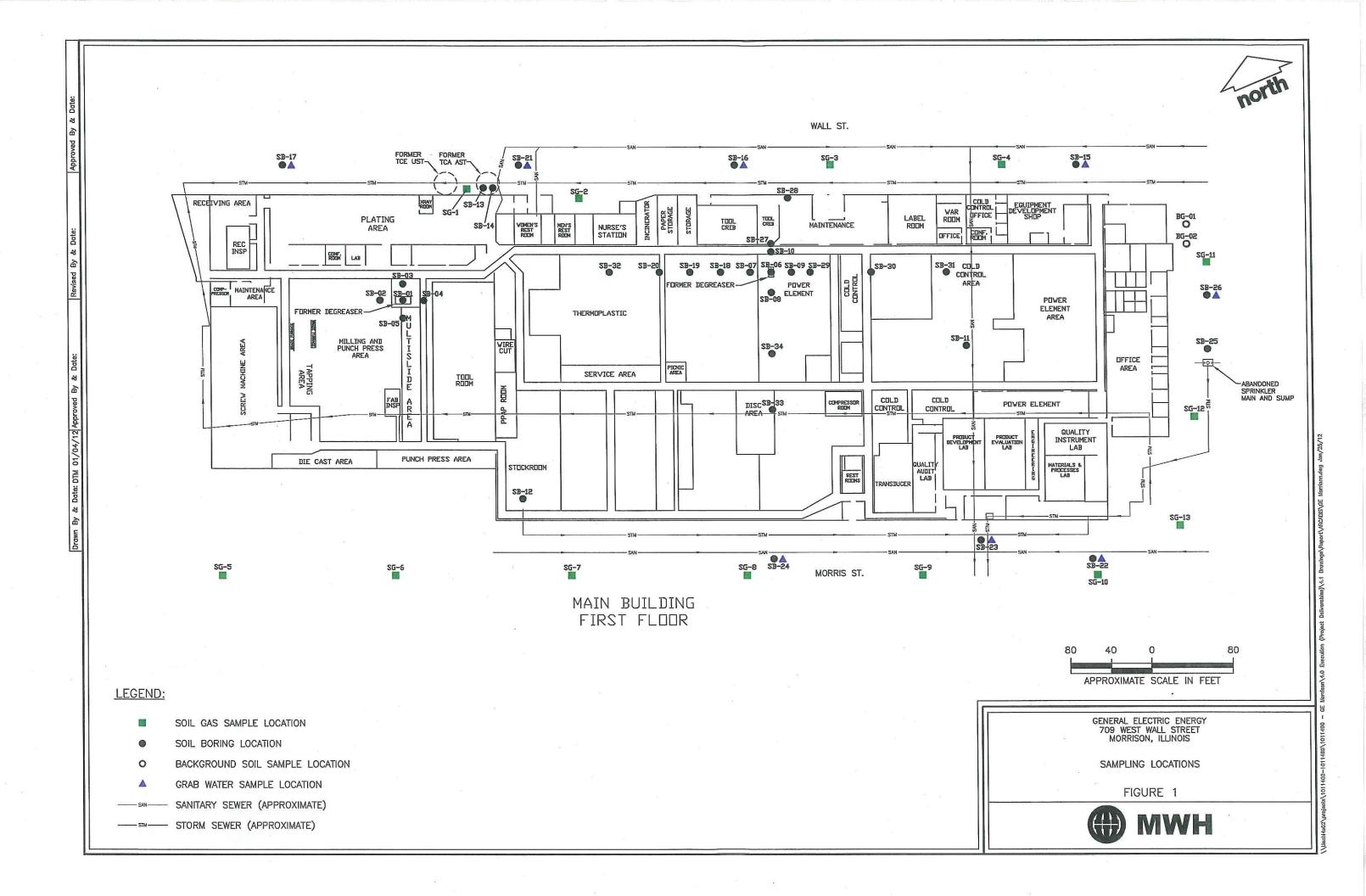
# **ARCADIS**

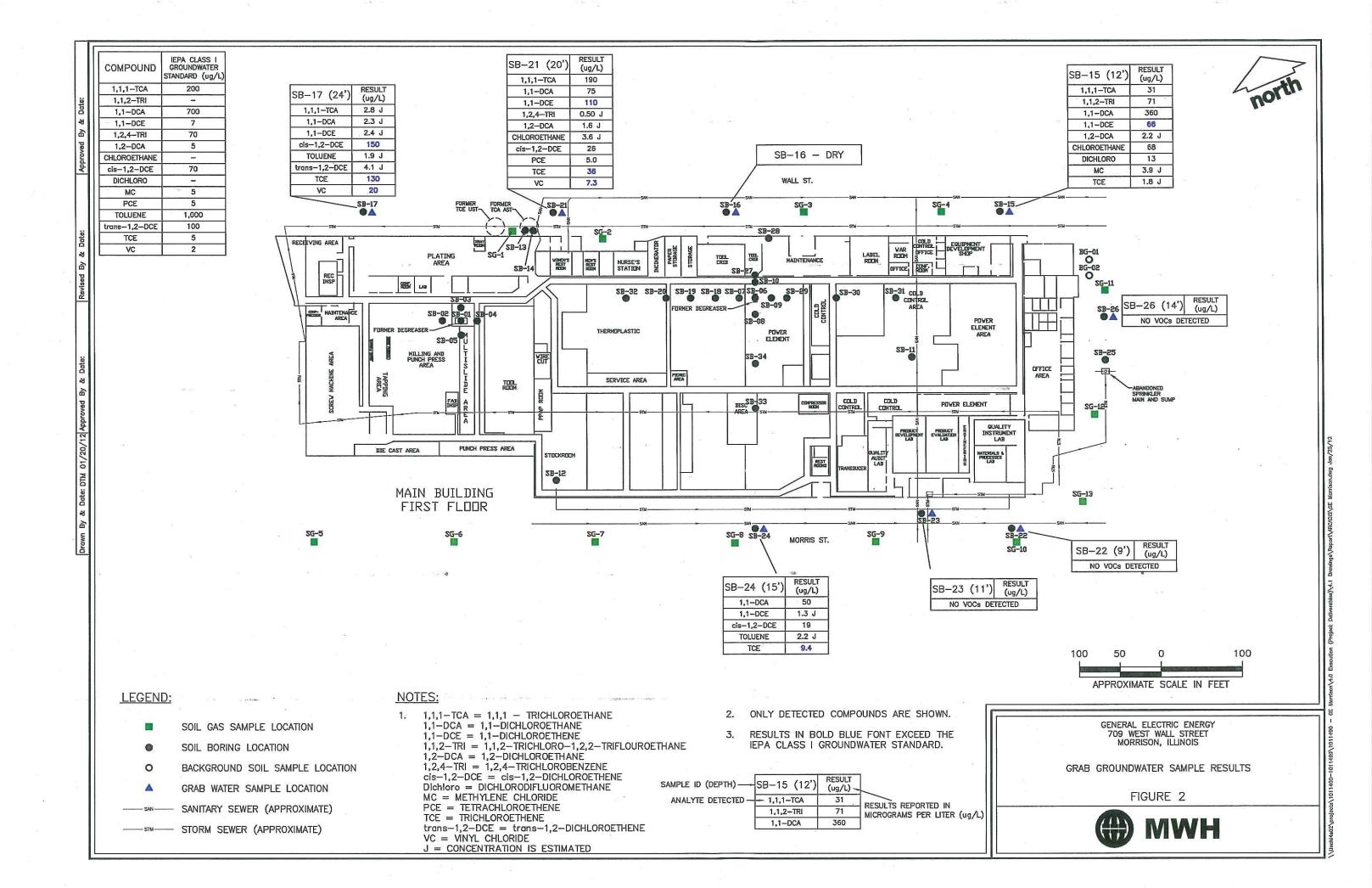
Table 3. Residential and Commercial Sample Locations, GE Morrison, Morrison, Illinois

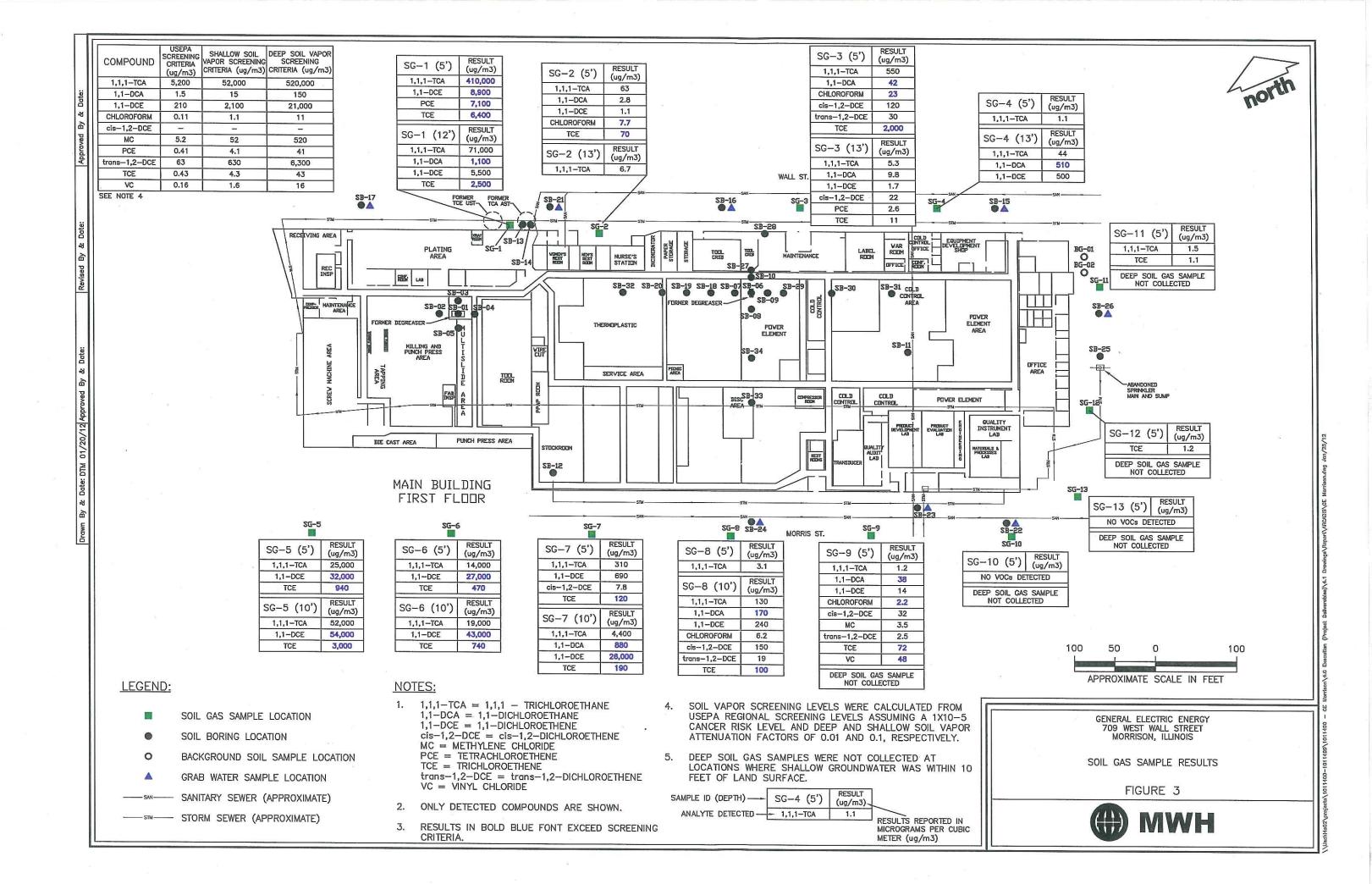
Parcel No. Parcel ID	Approximate Acres	Basement/ Crawl Space	Year Built	Dwelling Square Footage	Garage Square Footage	No. of Floors	Land Use	No. of Sub-slab Soil No. of Indoor Vapor Samples Air Samples	No. of Indoor Air Samples
0813277007	0.17	Full	1935	1344	576	11/2	Residential	1	٠ ـ ـ ـ
0813277006	0.17	Slab	1935	624	A/N	-	Residential	1	_
0813277005	0.17	Partial	1920	1610	A/N	-	Residential	2	_
0813277004	0.17	Full	1917	1736	Outbuilding	2	Residential	2	1
0813277003	0.17	Full	1930	961	Outbuilding	11/2	Residential	1	-
0813277002	0.34	Full	1930	929	1024	11/2	Residential	-	
0813276002	2.99	N/A	1958	3016	A/N	-	Commercial	2	2
0813277001	0.17	oN		4480	A/N	2	Commercial/Apartments	2	2

Notes:

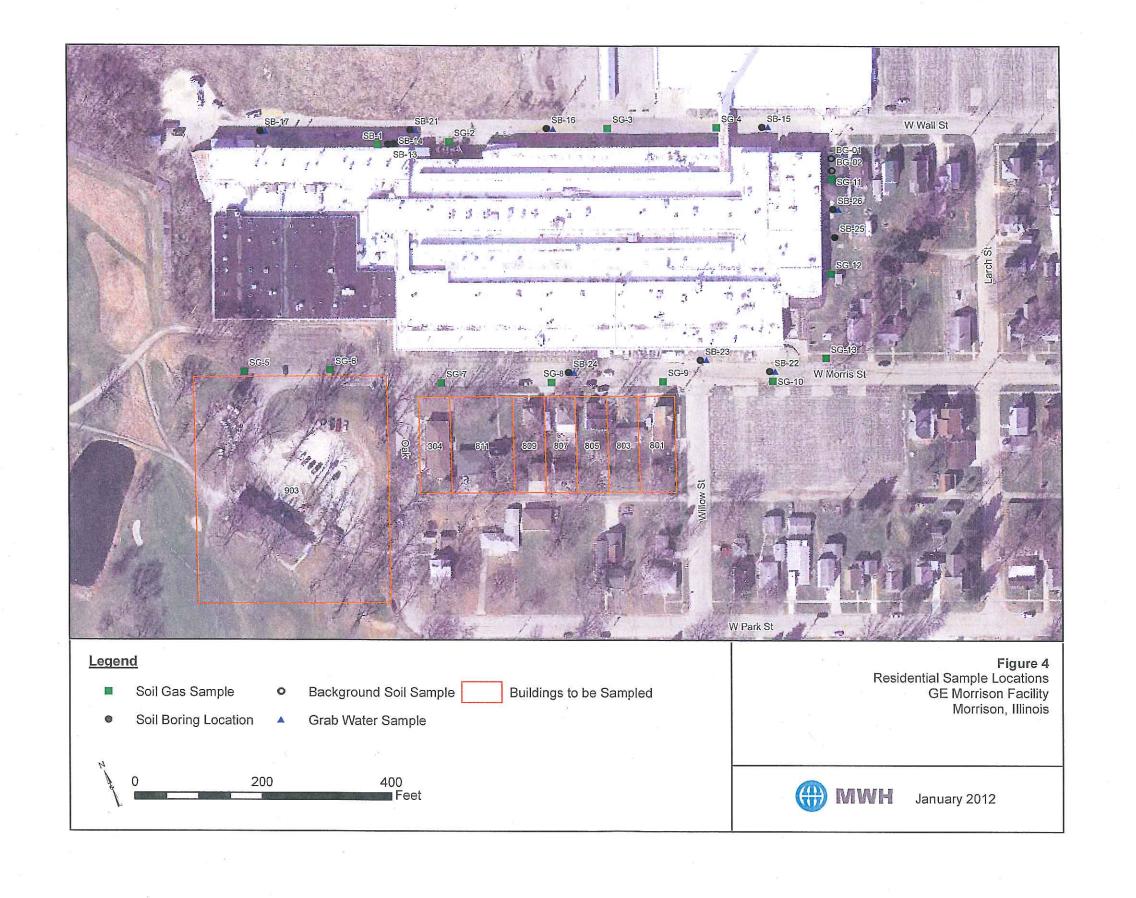
N/A - Not available







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# Appendix A

Building Survey and Product Inventory Form

# INDOOR AIR BUILDING SURVEY FORM

Preparer's name:	Date:
Preparer's affiliation:	Phone #:
Part I - Occupants	
Building Address:	
	Owner / Renter / other:
Contact's Phone: home ( )	work ( ) cell ( )
# of Building occupants: Children	n under age 13 Children age 13-18 Adults
Part II - Building Characteristic	<u>es</u>
Building type: residential / mult	i-family residential / office / strip mall / commercial / industrial
Describe building:	Year constructed:
Sensitive population: day care /	nursing home / hospital / school / other (specify):
Number of floors below grade:	(full basement / crawl space / slab on grade)
Number of floors at or above grade	
Depth of basement below grade su	rface:ft. Basement size:ft²
Basement floor construction: con-	crete / dirt / floating / stone / other (specify):
Foundation walls: poured cor	ncrete / cinder blocks / stone / other (specify)
Basement sump present? Yes / N	Vo Sump pump? Yes / No Water in sump? Yes / No
	hot air radiation wood steam radiation hot water radiation kerosene heater electric baseboard
Type of ventilation system (circle a central air conditioning conditioning units other (specify):	
Type of fuel utilized (circle all that Natural gas / electric / fu	apply): nel oil / wood / coal / solar / kerosene
Are the basement walls or floor sea	aled with waterproof paint or epoxy coatings? Yes / No
Is there a whole house fan?	Yes / No
Septic system?	Yes / Yes (but not used) / No
Irrigation/private well?	Yes / Yes (but not used) / No

Existing subsurface depressurizat	ion (radon) system in place?	Yes / No	active / passive
Sub-slab vapor/moisture barrier in	n place? Yes / No Type of barri	ier:	
Part III - Outside Sources			
Contaminated or other industrial	site (1000-ft. radius):		
	gas stations, emission stacks, etc.):		
ileavy veniculal traffic heartly (o.	r other mobile sources):		
Part IV – Indoor Contaminant	Sources		
	es found in the building (including was removed from the building property)  Location(s)	rior to indoor air san	
Gasoline storage cans			
Gas-powered equipment			
Kerosene storage cans			
Paints / thinners / strippers			
Cleaning solvents			
Oven cleaners			
Carpet / upholstery cleaners			
Other house cleaning products			
Moth balls			
Polishes / waxes			
Insecticides			
Furniture / floor polish			
Nail polish / polish remover			
Hairspray			
Cologne / perfume			
Air fresheners			
Fuel tank (inside building)			NA
Wood stove or fireplace			NA
New furniture / upholstery	·		
New carpeting / flooring			NA
Hobbies - glues, paints, etc.			
	+ +*		
Part V – Miscellaneous Items			
Do any occupants of the building	smoke? Yes / No	How often? _	
Last time someone smok	ed in the building?	hours / days	ago

Does the building have an attached garage directly connected to living space? Yes / No
If so, is a car usually parked in the garage? Yes / No
Are gas-powered equipment or cans of gasoline/fuels stored in the garage? Yes / No
Do the occupants of the building have their clothes dry cleaned? Yes / No
If yes, how often? weekly / monthly / 3-4 times a year
Do any of the occupants use solvents in work? Yes / No
If yes, what types of solvents are used?
If yes, are their clothes washed at work? Yes / No
Have any pesticides/herbicides been applied around the building or in the yard?  Yes / No
If so, when and which chemicals?
Has there ever been a fire in the building? Yes / No If yes, when?
Has painting or staining been done in the building in the last 6 months?  Yes / No
If yes, when and where?
Part VI – General Observations
Provide any information that may be pertinent to the sampling event and may assist in the data interpretation process.



# Appendix B

Instructions for Occupants during Indoor Air Sampling Events

# Instructions for Occupants for Indoor Air Sampling

Your assistance is requested during the indoor air sampling program in order to collect an indoor air sample that is both representative of indoor conditions and avoids the common background indoor air sources associated with home owner or building activities and consumer products.

Please follow the instructions below starting at least 24 hours prior to and during the indoor air sampling event:

- Operate your furnace and whole house air conditioner as appropriate for the current weather conditions
- Do not use wood stoves, fireplaces or auxiliary heating equipment
- · Do not open windows or keep doors open.
- Avoid using window air conditioners, fans or vents
- · Do not smoke in the building
- · Do not use air fresheners or odor eliminators
- Do not use paints or varnishes (up to a week in advance, if possible)
- Do not use cleaning products (e.g., bathroom cleaners, furniture polish, appliance cleaners, allpurpose cleaners, floor cleaners)

- Do not use cosmetics, including hair spray, nail polish remover, perfume, etc.
- Avoid bringing freshly dry cleaned clothes into the building
- Do not engage in hobbies indoors that use solvents
- Do not apply pesticides
- Do not store containers of gasoline, oil or petroleum based or other solvents within the building or attached garages (except for fuel oil tanks)
- Do not operate or store automobiles in an attached garage
- Do not operate gasoline powered equipment within the building, attached garage or around the immediate perimeter of the building

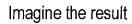
You will be asked a series of questions about the structure, consumer products you store in your building, and occupant activities typically occurring in the building. These questions are designed to identify "background" sources of indoor air contamination. While this investigation is looking for a select number of chemicals related to the subsurface contamination, the laboratory will be analyzing the indoor air samples for several chemicals. As a result, chemicals such as tetrachloroethene that is commonly used in dry cleaning might be detected in your sample results.

Your cooperation is greatly appreciated.



# Appendix C

Standard Operating Procedures





# Sub-Slab Soil Gas Sampling and Analysis Using USEPA Method TO-15 – Permanent Probe Approach

**SOP #1** 

Rev. #: 2

Rev Date: July 7, 2010

Rev. #: 2 | Rev Date: July 7, 2010

### **Approval Signatures**

Prepared by:

Mitch Wacksman and Andrew Gutherz

Date: 07/07/2010

Approved by:

Christopher Lutes and Nadine Weinberg

Date: <u>07/07/2010</u>

SOP: Sub-Slab Soil Gas Sampling and Analysis Using USEPA Method TO-15  $-\,$ 

Rev. #: 2 | Rev Date: July 7, 2010

Permanent Probe Approach

### I. Scope and Application

This document describes the procedures for installing permanent sub-slab sampling probe and collecting sub-slab soil-gas samples for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). Method TO-15 uses a 1-liter, 3-liter or 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of 6 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for installing permanent sub-slab soil-gas probes and collecting soil-gas samples for VOC analysis.

#### II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading sub-slab soil gas sample collection activities must have previous sub-slab soil gas sampling experience.

### III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling must be carefully performed to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment or directly supervised by an experienced person and with the appropriate health and safety measures in place as presented in the JLA. It is possible to encounter high concentrations of VOCs in sub-slab soil gas, so the amount of time the borehole remains open should be minimized. For the same reason, when installing sub-slab probes in spaces with minimal dilution potential, such as closets, it is advisable to provide local ventilation. Finally, sub-slab probe installation should be

Rev. #: 2 | Rev Date: July 7, 2010

completed 24 hours in advance or after any indoor air sampling to avoid cross contamination of the indoor air samples.

### IV. Equipment List

The equipment required to <u>install a permanent sub-slab soil gas probe</u> is presented below:

- Appropriate personal protective equipment (PPE; as required by the site specific HASP and the JLA)
- Electric hammer drill (big Bosch, Hilti, etc.);
- 1/2-inch and 1 ½-inch diameter concrete drill bits for impact drill (drill bit length contingent on slab thickness;
- Decontaminated stainless steel vapor probe (typically 1/4-inch outside diameter [OD] stainless steel tubing, 1/4-inch Swagelok by 1/4-inch Swagelok female coupling, (or equilivant), 1/4-inch Swagelok cap);
- Extra ¼-inch Swagelok front and back compression sleeves;
- Stainless steel washers;
- Tubing cutter with heavy-duty cutting wheel;
- Hand tools, including open-end wrench (typically <sup>9</sup>/<sub>16</sub>-inch), pliers, channel lock pliers, etc.;
- Teflon tape;
- Quick-setting non-shrink grout powder;
- Potable water for mixing grout;
- · Disposable cups and spoons for mixing grout;
- Spray bottle with potable water;
- Whisk broom and dust pan;
- Paper towels;

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- Nitrile gloves;
- · Work gloves;
- Knee pads;
- Bottle brush;
- Ground fault circuit interrupter (GFCI);
- Extension cords capable of amperage required for hammer drill;
- Plastic sheeting; and
- Shop vacuum with clean fine-particle filter.

The equipment required for sub-slab soil gas sample collection is presented below:

- 1,3, or 6 liter stainless steel SUMMA® canisters (order at least one extra, if feasible) (batch certified canisters or individual certified canisters as required by the project);
- Flow controllers with in-line particulate filters and vacuum gauges; flow
  controllers are pre-calibrated to specified sample duration (e.g.,30 minutes) or
  flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory
  that the flow controller comes with an in-line particulate filter and pressure
  gauge (order at least one extra, if feasible);
- 1/4-inch ID tubing (Teflon®, or similar);
- 1/4-inch Swagelok by 1/8-inch NPT male stainless steel coupling;
- Extra1/4-inch Swagelok front and back compression sleeves
- Decontaminated stainless steel Swagelok or comparable "T" fitting and needle valve for isolation of purge pump;
- Two 3-inch lengths of 1/4-inch OD Teflon tubing
- Stainless steel duplicate "T" fitting provided by the laboratory (if collecting duplicate [i.e., split] samples);

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- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 mL/min) with vacuum gauge;
- Rotameter or an electric flow sensor if vacuum pump does not have an accurate flow gauge (Bios DryCal or equivalent);
- Tracer gas testing supplies (refer to "Administering Tracer Gas" SOP #2);
- Appropriate-sized open-end wrench (typically 9/16-inch and ½");
- Tedlar<sup>®</sup> bag to collect purge air or length of tubing sufficient to vent it outside the structure;
- Portable weather meter, if appropriate;
- Chain-of-custody (COC) form;
- Sample collection log (attached);
- Nitrile gloves;
- · Work gloves;
- Field notebook

#### V. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a sub-slab soil-gas sample.

- When drilling sample collection holes, be mindful of utilities that may be in the area. Always complete utility location, identification and marking before installing subslab ports as required by the ARCADIS Utility Location Policy and Procedure. Be aware that public utility locator organizations frequently do not provide location information within buildings so alternative lines of evidence must be used. If the driller is concerned about a particular location, consult the project manager about moving it to another location. Do not hesitate to use Stop Work Authority; if something doesn't seem right stop and remedy the situation.
- Supplies such as stainless steel tubing and drill bit length will be based on the
  thickness of the slab encountered. Every effort will be made to establish the
  thickness of the slab during the preliminary investigation activities, such as

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interviews with site personnel, review of construction drawings, building walk through and utility clearance process.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.
- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure.
   Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 3 -7 – inches Hg) remains in the canister when sample collection is terminated.
- Field personnel will properly seal the vapor port at the slab surface to prevent leaks of atmosphere into the soil gas port during purging and sampling.
   Permanent ports will be fit snug into the predrilled hole using Teflon tape or modeling clay and cemented into the ground. If this is not done properly, the integrity of the sample port may be compromised.
- It is important to record the canister pressure, start and stop times, and sample identification on a proper field sampling form. Often SUMMA canisters are collected with a 24-hour averaging period. You should observe and record the time/pressure at the start, and then again one or two hours after starting the sample collection. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it is not stuck. If the canister is running correctly for a 24-hour period, the vacuum will have decreased slightly after one or two hours (for example from 29 inches to 27 inches). Consult your project manager, risk assessor or air sampling expert by phone if the SUMMA canister does not appear to be working properly.
- Ensure that there is still measureable vacuum in the SUMMA® after sampling.
   Sometimes the gauges sent from labs have offset errors, or they stick.
- Many times the gauges sent from labs have large offset errors, or the gauge needle does not move freely in response to changes in vacuum. For the most precise pressure readings, consider using a separate, more sensitive, device to check pressure at the beginning of the sampling period in a clean atmosphere. This should be done without moving a significant flow into the canister for example using a pressure gauge on a dead-end leg. If used, this device must be tested beforehand to confirm that it does not introduce contaminants to the SUMMA canister during pressure checks

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- When sampling carefully consider elevation. If your site is over 2,000' above sea level or the difference in elevation between your site and your lab is more than 2,000' then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them. http://www.uigi.com/Atmos pressure.html.
- If possible, have equipment shipped a two to three days before the scheduled start
  of the sampling event so that all materials can be checked. Order replacements if
  needed.
- Requesting extra canisters and flow controllers from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.
- Check the seal around the soil-gas sampling port by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document. See SOP "Administering Tracer Gas" #2.

#### VI. Procedure

### **Permanent Vapor Probe Installation**

Permanent sub-slab soil gas probes are installed using an electric drill and manual placement of the probe. After a dry fit, the probe is inserted into the hole and grouted with a quick-setting non-shrink grout powder. The probe is equipped with a plug. The cap is removed and a compression fitting nut and ferrules are used to allow collection of a soil gas sample through Teflon tubing. The probe and tubing will be purged with a portable sampling pump prior to collecting the soil gas sample. Detailed installation methods are as follows:

- 1. Complete the ARCADIS Utility Locate procedure prior to drilling activities.
- Assemble the sample port assembly (stainless steel tubing, stainless steel Swagelok coupling, Swagelok nut). Teflon tape should never be used with Swagelok connections.
- 3. Remove, only to the extent necessary, any covering on top of the slab (e.g., carpet) if present.

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- Lay down plastic sheeting to keep the work area clean. Check to make sure shop vacuum is working properly and fine concrete particles will not pass through filter.
- 5. Advance the 1½-inch drill bit approximately 1½ inches into the slab. This hole is drilled deep enough to permit the top of the coupling to be set flush with the slab when the ¼-inch tubing is inserted into the ½-inch hole drilled under Step 7, below. Clean up cuttings with shop vacuum, bottle brush, and dust pan.
- Drill a 1/2-inch-diameter hole into the concrete slab using the electric drill. Do
  not fully penetrate the slab at this time. Stop drilling approximately 1 inch short
  of penetrating the slab.
- 7. Use the shop vacuum, bottle brush and dust broom to clean up the work area and material that may have fallen into and around the drill hole.
- 8. Advance the 1/2-inch drill bit the remaining thickness of the slab and approximately 3 inched into the sub-slab material to create an open cavity. Record any observations from the drill cuttings if possible regarding approximate soil types and presence or absence of a plastic subslab sheet.
- Use the bottle brush, dust broom and dust pan to clean material around and within the hole. Do not use the shop vacuum to clean up the drill hole after the full thickness of the slab has been penetrated.
- 10. Using an assembled sample probe assembly, test fit the components so that the proper length of ¼-inch tubing and depth of the 1½-inch hole provides enough space for the stainless steel coupling. Adjust so that the coupling will lie flush with the slab surface and does not create a tripping hazard.
- Redrill the ½ inch hole to ensure it remains clear. This can also be accomplished using a piece of steel rod, sample tubing or a piece of heavy wire (e.g., coat hanger).
- 12. Wrap the sample probe assembly with Teflon tape, to the extent necessary, for a snug fit of the assembly and hole. Teflon tape or stainless steel washers can also be used to achieve the proper depth of the sample port assembly. Ensure that Teflon tape or stainless steel washers do not interfere with the cement that will be used to permanently fix and seal the sample probe.
- Prepare a mixture of nonshrink cement and water according to the manufactures directions in a disposable cup using a plastic spoon for mixing.

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- 14. Before cementing in the sample probe, moisten the bore hole with the spray bottle to provide better adhesion
- 15. Cement in the sample probe using the plastic spoon to apply the cement into the annular space between the coupling and the 1½-inch drill hole
- 16. Replace the surface covering (e.g., carpet) if warranted. Sample collection location should be returned to presampling conditions to the extent feasible given the presence of a permanent probe.
- 17. All permanent sub-slab sample probes should be allowed to sit and equilibrate for a minimum of 24 hours before proceeding to sample collection.

### **Sub-Slab Soil-Gas Sample Collection**

Once the permanent sample port is installed, the following procedures should be used to collect the sample in a SUMMA canister

- Record the following information on the sample log, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):
  - a. wind speed and direction;
  - b. ambient temperature;
  - barometric pressure; and
  - d. relative humidity.
- 2. Assemble the sample train by removing the cap from the SUMMA canister and connecting the Swagelok T-fitting to the can using a short length of 1/4-inch OD stainless steel tubing. The flow controller with in-line particulate filter and vacuum gauge is then attached to the T-fitting. The Swagelok two-way valve is connected to the free end of the T-fitting using a short length of ¼-inch OD Teflon tubing.
- 3. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA canisters using stainless steel Swagelok duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.

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- 4. Attach Teflon sample tubing to the flow controller using Swagelok fittings.
- Remove the flush hex plug and install the male treaded coupling fitting into the sub-slab port, applying Teflon tape to seal the NPT threaded male end. Teflon tape should never be used on Swagelok compression fitting connections.
- 6. Connect the male threaded coupling fitting and the flow controller using a length of Teflon sample tubing.
- 7. Connect the two-way valve and the portable purge pump using a length of Teflon sample tubing.
- 8. Record on the sample log and COC form the flow controller number with the appropriate SUMMA® canister number.
  - a. Perform a leak-down-test by replacing the nut which secures sample tubing with the cap from the canister. This will create a closed system. Open the canister valve and quickly close it; the vacuum should increase approaching 30" Hg. If there are no leaks in the system this vacuum should be held. If vacuum holds proceed with sample collection; if not attempt to rectify the situation by tightening fittings. (See SOP#3)
  - 9. Open the two-way valve and purge the soil gas sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil-gas sampling port and sampling line using a flow rate of 200 mL/min. Purge volume is calculated by the following equation "purge volume = 3 x Pi x inner radius of tubing<sup>2</sup> x length of tubing. Purge air will be collected into a Tedlar bag to provide that VOCs are not released into interior spaces. Measure organic vapor levels and tracer gas within the Tedlar bag, as appropriate.
- 10. The seal around the soil-gas sampling port and the numerous connections comprising the sampling train will be evaluated for leaks using helium as a tracer gas. The helium tracer gas will be administered according to the methods established in the appropriate guidance documents and SOP: Administering Helium Tracer Gas.
- 11. Close the two-way valve to isolate the purge pump.
- 12. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

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If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

- 13. Take a photograph of the SUMMA® canister and surrounding area.
- 14. Check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

### **Termination of Sample Collection**

- 1. Arrive at the SUMMA® canister location at least 1-2 hours prior to the end of the required sampling interval (e.g., 8, 24-hours).
- Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 6 inches of Hg or slightly greater).
- 3. Record the date and local time (24-hour basis) of valve closing on the sample collection log and COC form.
- 4. Disconnect sample tubing from the sample port; replace flush-mount cap.
- 5. Remove the particulate filter and flow controller from the SUMMA® canister, reinstall the brass plug on the canister fitting, and tighten with the appropriate wrench.
- Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.
- 7. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).
- Complete the COC form and place the requisite copies in a shipping container.
   Close the shipping container and affix a custody seal to the container closure.
   Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

### VII. Waste Management

No specific waste management procedures are required.

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### VIII. Data Recording and Management

Measurements will be recorded on the sample log at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the Project Manager.

### IX. Quality Assurance

Sib-slab soil gas sample analysis will be performed using USEPA TO-15 methodology. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5-ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent reanalyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

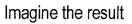
Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence.

<b>ARCADIS</b>		Sub-slab Soil Gas Sample Collection Log			
		7 (2000) 1000) 1000) 1000)	Sample ID:		
Client: Project: Location: Project #: Samplers: Sampling Depth: Time and Date of			Boring Equipment: Sealant: Tubing Information: Miscellaneous Equipment: Subcontractor: Equipment: doisture Content of Sampling Zone): Approximate		
Installation:		22.000 17.000 17.000 10.000	Purge Volume:		<u> </u>
Instrument Re					
Date	Canister Time Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Barometri Speed Pressure (mph) (inches of l	
(a) Record cani	ster information at a minimum a	at the beginning and	l end of sampling		
SUMMA (	Canister Information:		Tracer Tes	t Information (if appl	licable):
Size (circle one): Canister ID: Flow	1L 6L		Initial Helium Shroud: Final Helium Shroud: Tracer Test	Yes	No
Controller ID: Notes:	•		Passed: Notes:	tes	NO

### Approximating One-Well Volume (for purging):

**General Observations/Notes:** 

When using 1%-inch "Dummy Point" and a 6-inch sampling interval, the sampling space will have a volume of approximately 150 mL. Each foot of %-inch tubing will have a volume of approximately 10 mL.





# Administering Helium Tracer Gas for Leak Checks of Soil Gas or Sub-slab Sampling Points

SOP #2

Rev. #: 3

Rev Date: July 7, 2010

## **Approval Signatures**

Prepared by:		Date:	07/07/2010
	Mitch Wacksman and Andrew Gutherz		
Approved by:	Christopher Lutes and Nadine Weinberg	Date:	07/07/2010

### I. Scope and Application

When collecting subsurface vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control method to verify the integrity of the vapor port seal and the numerous connections comprising the sample train. Without the use of a tracer, verification that a soil vapor sample has not been diluted by ambient or indoor air is difficult.

This standard operating procedure (SOP) focuses on using helium as a tracer gas. However, depending on the nature of the contaminants of concern, other compounds can be used as a tracer including sulfur hexafluoride (SF6), butane and propane (or other gases). In all cases, the protocol for using a tracer gas is consistent and includes the following basic steps: (1) enrich the atmosphere in the immediate vicinity of the sample port where ambient air could enter the sampling train during sampling with the tracer gas; and (2) measure a vapor sample from the sample tubing for the presence of elevated concentrations (> 10%) of the tracer. A plastic pail, bucket, garbage can or even a plastic bag can serve to keep the tracer gas in contact with the port during the testing.

There are two basic approaches to testing for the tracer gas:

- Include the tracer gas in the list of target analytes reported by the laboratory; and/or
- Use a portable monitoring device to analyze a sample of soil vapor for the tracer
  prior to sampling for the compounds of concern. Note that tracer gas samples
  can be collected via syringe, Tedlar bag, etc. They need not be collected in
  SUMMA® canisters.

This SOP focuses on monitoring helium using a portable sampling device, although helium can also be analyzed by the laboratory along with other volatile organic compounds (VOCs). Real-time tracer sampling is generally preferred as the results can be used to confirm the integrity of the port seals prior to formal sample collection.

During the initial stages of a subsurface vapor sampling program, tracer gas samples should be collected at each of the sampling points. If the results of the initial samples indicate that the port seals are adequate, the Project Manager can consider reducing the number of locations at which tracer gas samples are used in future monitoring rounds. At a minimum, at least 5% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor points as part of a long-term monitoring program, the port should be tested prior to the first sampling event. Tracer gas testing of subsequent sampling events may often be reduced or eliminated unless conditions have changed at the site. Soil vapor port integrity should certainly

be rechecked with Tracer gas if land clearing/grading activities, freeze thaw cycles, or soil dessication may have occurred. Points should also be rechecked if more than 2 years have elapsed since the last check of that port.

### II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading the tracer gas testing must have previous experience conducting similar tests.

### III. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field staff should review the attachment on safely handling compressed gas cylinders prior to commencing field work.

### IV. Equipment List

The equipment required to conduct a helium tracer gas test is presented below:

- Appropriate PPE for site (as required by the HASP)
- Helium (laboratory grade)
- · Regulator for helium tank
- Shroud (plastic bucket, garbage can, etc)
  - The size of the shroud should be sufficient to fit over the sample port. It is worth noting that using the smallest shroud possible will miminze the volume of helium needed; this may be important when projects require a large number of helium tracer tests.
  - The shroud will need to have three small holes in it. These holes will include one on the top (to accommodate the sample tubing), and two

on the side (one for the helium detector probe, and one for the helium line).

- The shroud should ideally enclose the sample port and as much as possible of the sampling train.
- Helium detector capable of measuring from 1 100% (Dielectric MGD-2002, Mark Model 9522, or equivalent)
- Tedlar bags
- Seal material for shroud (rubber gasket, modeling clay, bentonite, etc) to keep helium levels in shroud high in windy conditions. Although the sealing material is not in direct contact with the sample if leakage does not occur, sealing materials with high levels of VOC emissions should be avoided, since they could contaminate a sample if a leak occurs.
- Sample logs
- Field notebook

#### V. Cautions

Helium is an asphyxiant. Be cautious with its use indoors. Never release large volumes of helium within a closed room.

Compressed gas cylinders should be handled with caution; see attachment on the use and storage of compressed gasses before beginning field work.

Care should be taken not to pressurize the shroud while introducing helium. If the shroud is completely air tight and the helium is introduced quickly, the shroud can be over-pressurized and helium can be pushed into the ground. Provide a relief valve or small gap where the helium can escape.

Because minor leakage around the port seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the port seal should be enhanced and fittings within the sampling train should be should be checked and/or tightened to reduce the infiltration of ambient air and the tracer test readministered. If the problem cannot be rectified, a new sample point should be installed or an alternate sampling train used.

#### VI. Procedure

The procedure used to conduct the helium tracer test should be specific to the shroud being used and the methods of vapor point installation. The helium tracer test can be conducted when using temporary or permanent sampling points and inside or outside a facility. When using the tracer gas within indoor areas you must provide adequate ventilation as helium is an asphyxiant.

- 1. Attach Teflon sample tubing to the sample point.
- 2. Place the shroud over the sample point and tubing.
- 3. Pull the tubing through hole in top of shroud. Seal opening at top of shroud with modeling clay.
- 4. Place weight on top of shroud to help maintain a good seal with the ground.
- 5. Insert helium tubing and helium detector probe into side of shroud. Seal both with modeling clay to prevent leaks.
- Fill shroud with helium. Fill shroud slowly, allowing atmospheric air to escape either by leaving a gap where the shroud meets the ground surface or by providing a release value on the side of the shroud.
- 7. Use the helium detector to monitor helium concentration within the shroud from the lowest hole drilled in the shroud (bottom of the shroud nearest where the sample tubing intersects the ground). Helium should be added until the environment inside the shroud has > 60% helium.
- 8. Purge the sample point through the sample tubing into a Tedlar bag using a hand held sampling pump. The purge rate should at least match the sample collection rate but not exceed 100 ml/min. Test the air in the Tedlar bag for helium using portable helium detector. If the point is free of leaks there should be very low helium in the purge air from the soil. The natural concentration of helium in the atmosphere is 0.00052% by volume and there are few if any natural sources of helium to soil gas.
- If > 10% helium is noted in purge air, add more clay or other material to the seal the sample port and repeat the testing procedure. If the seal cannot be fixed, reinstall sample point.
- Monitor and record helium level in shroud before, during and after tracer test.

- 11. Monitor and record helium level in purge exhaust.
- 12. At successful completion of tracer test and sample point purging, the soil vapor sample can be collected (if the helium shroud must be removed prior to sample collection be mindful not disturb the sample tubing and any established seals).

### VII. Data Recording and Management

Measurements will be recorded on the sample logs at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location, and the helium concentrations in both the shroud and the purge air before, during, and after tracer testing. Any problems encountered should also be recorded in the field notes.

### ATTACHMENT: Compressed Gases—Use and Storage

In general, a compressed gas is any material contained under pressure that is dissolved or liquefied by compression or refrigeration. Compressed gas cylinders should be handled as high-energy sources and therefore as potential explosives and projectiles. Prudent safety practices should be followed when handling compressed gases since they expose workers to both chemical and physical hazards.

#### Handling

- Safety glasses with side shields (or safety goggles) and other appropriate personal protective equipment should be worn when working with compressed gases.
- Cylinders should be marked with a label that clearly identifies the contents.
- All cylinders should be checked for damage prior to use. Do not repair damaged cylinders
  or valves. Damaged or defective cylinders, valves, etc., should be taken out of use
  immediately and returned to the manufacturer/distributor for repair.
- All gas cylinders (full or empty) should be rigidly secured to a substantial structure at 2/3
  height. Only two cylinders per restraint are allowed in the laboratory and only soldered link
  chains or belts with buckles are acceptable. Cylinder stands are also acceptable but not
  preferred.
- Handcarts shall be used when moving gas cylinders. Cylinders must be chained to the carts
- All cylinders must be fitted with safety valve covers before they are moved.
- Only three-wheeled or four-wheeled carts should be used to move cylinders.
- A pressure-regulating device shall be used at all times to control the flow of gas from the cylinder.
- The main cylinder valve shall be the only means by which gas flow is to be shut off. The correct position for the main valve is all the way on or all the way off.
- Cylinder valves should never be lubricated, modified, forced, or tampered with.
- After connecting a cylinder, check for leaks at connections. Periodically check for leaks while the cylinder is in use.
- Regulators and valves should be tightened firmly with the proper size wrench. Do not use adjustable wrenches or pliers because they may damage the nuts.
- Cylinders should not be placed near heat or where they can become part of an electrical circuit.
- Cylinders should not be exposed to temperatures above 50 °C (122 °F). Some rupture
  devices on cylinders will release at about 65 °C (149 °F). Some small cylinders, such as
  lecture bottles, are not fitted with rupture devices and may explode if exposed to high
  temperatures.

- Rapid release of a compressed gas should be avoided because it will cause an unsecured gas hose to whip dangerously and also may build up enough static charge to ignite a flammable gas.
- Appropriate regulators should be used on each gas cylinder. Threads and the configuration
  of valve outlets are different for each family of gases to avoid improper use. Adaptors and
  homemade modifications are prohibited.
- Cylinders should never be bled completely empty. Leave a slight pressure to keep contaminants out.

### Storage

- When not in use, cylinders should be stored with their main valve closed and the valve safety cap in place.
- Cylinders must be stored upright and not on their side. All cylinders should be secured.
- Cylinders awaiting use should be stored according to their hazard classes.
- Cylinders should not be located where objects may strike or fall on them.
- Cylinders should not be stored in damp areas or near salt, corrosive chemicals, chemical vapors, heat, or direct sunlight. Cylinders stored outside should be protected from the weather.



# Leak Down Test

SOP # 3

Rev. #: 0

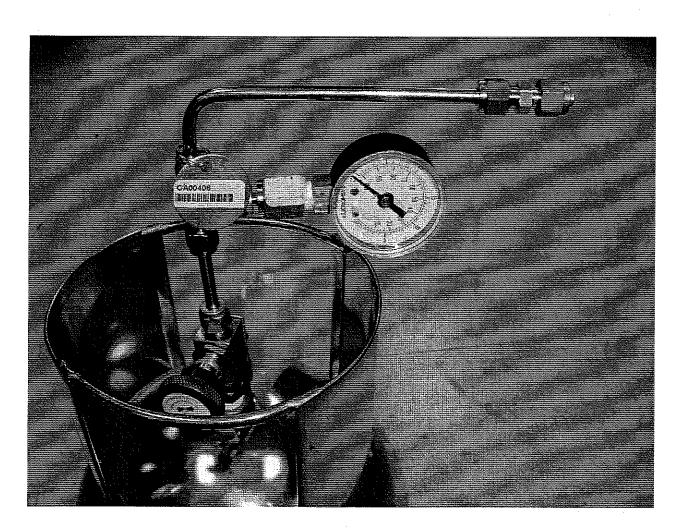
Rev Date: February 6, 2012

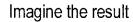
## **ARCADIS**

Standard Operating Procedure (SOP-3) Leak Down Test

To do a leak down test, follow these sampling steps:

- 1. Affix the gauge and flow controller to the canister.
- 2. Remove the Swagelok fitting from the end of the flow controller, where the tubing will eventually be affixed.
- 3. Place the cap from the canister on the end of the flow controller (see attached photo).
- 4. Open the canister and watch the vacuum gauge, it should immediately go to near -30" Hg.
- 5. Now close the valve. If all the fittings are working properly the system should be closed and it will preserve the vacuum shown on the gauge.
- 6. Wait about 2 minutes (maybe fill out the sample card in this time span or purge the sample port). The canister should still be holding the vacuum.
- 7. If the vacuum is preserved move on with collecting the sample. If not, attempt to remedy the situation by adjusting the fittings. If canister cannot be easily fixed, put canister aside and select a new can.







# Indoor Air or Ambient Air Sampling and Analysis Using USEPA Method TO-15

**SOP#4** 

Rev. #: 2

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Rev. #: 2 | Rev Date: July 7, 2010

## **Approval Signatures**

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Mitch Wacksman and Andrew Gutherz

Christopher Lutes and Nadine Weinberg

Date: 07/07/2010

Date: 07/07/2010

Rev. #: 2 | Rev Date: July 7, 2010

### I. Scope and Application

This standard operating procedure (SOP) describes the procedures to collect indoor air or ambient air samples for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter or 1-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA® canister (<28 inches of mercury [Hg]) will provide a recoverable whole-gas sample that can be analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and provide detailed instructions for placing the sampling device and collecting indoor air samples for VOC analysis.

### II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading indoor air sample collection activities must have previous indoor air sampling experience.

### III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. The following are examples of hazards that are often encountered in conducting indoor air sampling:

- In crawl spaces, hazards often include low head room, limited light, poisonous insects, venomous snakes, and sharp debris.
- In residential buildings and neighborhoods unfamiliar dogs can pose a
  hazard. Even though proper permission for sampling may have been
  secured, it is still possible to encounter persons suspicious of or hostile to the
  sampling team.
- In occupied industrial buildings be aware of the physical hazards of ongoing industrial processes. Examples include moving forklifts and equipment pits.

### IV. Equipment List

The equipment required for indoor air sample collection is presented below:

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- 6-liter or 1-liter stainless steel SUMMA® canisters (order at least one extra, if feasible);
- Flow controllers with in-line particulate filters and vacuum gauges (flow
  controllers are pre-calibrated by the laboratory to a specified sample
  duration [e.g., 8-hour]). Confirm with lab that flow controller is equipped
  with an in-line particulate filter and pressure gauge (order an extra set for
  each SUMMA® canister, if feasible);
- Appropriate-sized open-end wrenches (typically 9/16-inch);
- Chain-of-custody (COC) form;
- Building survey and product inventory form;
- Portable photoionization detector (PID), as needed (for use identifying potential background sources during building survey described below);
- Sample collection log (attached);
- Camera if photography is permitted at sampling locations;
- Portable weather meter, if appropriate;
- Box, chair, tripod, or similar to hold canister above the ground surface; and
- Teflon sample tubing may be used to sample abnormal situations (i.e., sumps, where canisters must be hidden, etc.). In these situations ¼-inch Swagelok fittings or other methods may be appropriate to affix tubing to canister. Staff should check this before heading out into field.

#### V. Cautions

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, keep ambient air canisters away from heavy pedestrian traffic areas (e.g., main entranceways, walkways) if possible. If the canisters are not to be overseen for the entire sample duration, precautions should be taken to maintain the security of the sample (e.g., do not place in areas regularly accessed by the public, fasten the sampling device to a secure object using lock and chain, label the canister to indicate it is part of a scientific project, notify local authorities, place the canister in secure housing that does not disrupt the integrity/validity of the sampling event). Sampling personnel should not handle hazardous substances (such as gasoline),

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permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes before and/or during the sampling event.

Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 5–inches Hg) remains in the canister when sample collection is terminated.

#### VI. Procedure

### Initial Building Survey for Indoor Air Samples (if applicable to project)

- Complete the appropriate building survey form and product inventory form (e.g., state-specific form, USEPA form, or ARCADIS form) as necessary in advance of sample collection.
- Survey the area for the presence of items or materials that may potentially
  produce or emit constituents that interfere with analytical laboratory analysis of
  the collected sample. Record relevant information on survey form and document
  with photographs.
- 3. Record date, time, location, and other relevant notes on the sampling form.
- 4. Items or materials that contain constituents of concern and/or exhibit elevated PID readings shall be considered probable sources of VOCs. Request approval of the owner or occupant to have these items removed to a structure not attached to the target structure prior to sampling if possible.
- Set a date and time with the owner or occupant to return for placement of SUMMA® canisters.

### Preparation of SUMMA®-Type Canister and Collection of Sample

- Record the following information on the sampling form (use a hand-held weather meter, contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):
  - ambient temperature;
  - barometric pressure;

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- wind speed; and
- relative humidity.
- 2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, box, or other similar stand to locate the canister orifice 3 to 5 feet above ground or floor surface. If the canister will not be overseen for the entire sampling period, secure the canisters as appropriate (e.g., lock and chain). Canister may be affixed to wall/ceiling support with nylon rope or placed on a stable surface. In general, areas near windows, doors, air supply vents, and/or other potential sources of "drafts" shall be avoided.
- Record SUMMA® canister serial number and flow controller number on the sampling log and chain of custody (COC) form. Assign sample identification on canister ID tag, and record on the sample collection log (Attachment A), and COC form.
- 4. Remove the cap from the SUMMA® canister. Attach the flow controller with inline particulate filter and vacuum gauge to the SUMMA® canister with the appropriate-sized wrench. Tighten with fingers first, then gently with the wrench. Use caution not to over tighten fittings.
- 5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening on the sample collection log, and COC form. Collection of duplicate samples will include collecting two samples side by side at the same time.
- Record the initial vacuum pressure in the SUMMA® canister on the sample log and COC form. If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.
- 7. Take a photograph of the SUMMA® canister and surrounding area, if possible.
- 8. Check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

### **Termination of Sample Collection**

1. Arrive at the SUMMA® canister location at least 1-2 hours prior to the end of the sampling interval (e.g., 8-hour, 24-hour).

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- 2. Stop collecting the sample when the canister vacuum reaches approximately 5 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.
- Record the final vacuum pressure. Stop collecting the sample by closing the 3. SUMMA® canister valve. Record the date, local time (24-hour basis) of valve closing on the sample collection log, and COC form.
- 4. Remove the particulate filter and flow controller from the SUMMA® canister, reinstall cap on canister fitting, and tighten with wrench.
- 5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.
- 6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with string).
- 7. Complete COC form and place requisite copies in shipping container. Close shipping container and affix custody seal to container closure. Ship to laboratory via overnight carrier (e.g., Federal Express) for analysis.

#### VII. **Waste Management**

No specific waste management procedures are required.

### VIII. Data Recording and Management

Notes taken during the initial building survey will be recorded on the sample log, with notations of project name, sample date, sample time, and sample location (e.g., description and GPS coordinates if available) sample start and finish times, canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Sample logs and COC records will be transmitted to the Task Manager or Project Manager. A building survey form and product inventory form may also be completed for each building within the facility being sampled during each sampling event as applicable.

#### IX. **Quality Assurance**

Indoor air or ambient air sample analysis will be performed using USEPA Method TO-This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. This system also offers the advantage of the GC/MS SOP: Indoor Air Sampling and Analysis Using USEPA Method TO-15

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detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence.

<b>ARCADIS</b>				Indoor Air/Ambient Air Sample Collection Log				
				Sample ID:				
Client:				Outdoor/Indoor:				
Project:		M		Sample Intake Height:				
Location:				Tubing Information:			••••	
Project#:				Miscellaneous Equipment:				
Samplers:				Time On/Off:				
ample Point Location:				Subcontractor:				
	Time	Canister Vacuum (a) (inches of Hg)	Temperature (°F)	Relative Humidity (%)	Air Speed (mph)	Barometric Pressure (inches of Hg)	PIE (ppl	
Date								
a) Record canis	ster information	n at a minimum a	at the beginning a	and end of sampling				
a) Record canis		n at a minimum a	at the beginning a	and end of sampling				
Size (circle one): Canister ID:	anister Info	n at a minimum a	at the beginning a	and end of sampling				
a) Record canis  SUMMA C  Size (circle one):	anister Info	n at a minimum a	at the beginning a	and end of sampling				
Size (circle one): Canister ID: Flow	anister Info	n at a minimum a	at the beginning a	and end of sampling				